Beyond your imagination

EverGreen Plus

2.5" SATA SSD Series

Customer: ______________________________

Customer Part Number: ______________________________

InnoDisk Part Number: ______________________________

InnoDisk Model Name: ______________________________

Date: ______________________________

InnoDisk Approver	Customer Approver

the total solution for
industrial flash storage

Table of contents

REVISION HISTORY

Revision	Description	Date
Preliminary	First Released	12/30/2010
Rev.0.1	1. Add PN rule	1/24/2011
Rev.0.2	1. Add section of Power cycling protection and circuit design 2. Add IOPS info.	2/24/2011
Rev.0.3	1. Modify Par Number Rule and available capacity info.	5/23/2011
Rev. 1.0	1. Modify product performance 2. Updated CHS table with LBA information 3. Updated power consumption	7/29/2011
Rev. 1.1	1. Update mechanical dimensions 2. Modify IOPS info.	8/8/2011
Rev. 1.2	1. Updated 8GB CHS table with LBA information	9/15/2011
Rev. 1.3	1. Add industrial temperature information	10/05/2011

List of Tables

List of Figures

1 Product Overview

1.1 Introduction of EverGreen / EverGreen Plus* SATA SSD

InnoDisk Evergreen series provides a totally brand new highly cost-effective SSD solution with good performance and longer lifespan. Customer can pay much less but embrace longer life and performance than current SLC flash IC based SSD solutions. Evergreen Series SSDs is a **perfect substitute** for traditional HDD, which are applied with an **evolved L^2 Wear Leveling Architecture**, and significantly improves SSD **random data transfer rate and lifespan.**

EverGreen Plus 2.5” SATA SSD provides high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA (SATA) standard, and supports SATA II standard (3.0GHz) with high performance. It has good performance; no latency time and small seek time. It effectively reduces the booting time of operation system and the power consumption is less than hard disk drive (HDD).

* **L^2 Architecture** provides two different versions to enhance sequential performance (EverGreen) and extended lifespan (EverGreen Plus) respectively.

1.2 Product View



Figure 1: EverGreen Plus 2.5” SATA SSD

1.3 Product Models

EverGreen Plus 2.5” SATA SSD is available in follow capacities.

EverGreen Plus 2.5” SATA SSD 8GB EverGreen Plus 2.5” SATA SSD 16GB

EverGreen Plus 2.5” SATA SSD 32GB EverGreen Plus 2.5” SATA SSD 64GB

EverGreen Plus 2.5” SATA SSD 128GB EverGreen Plus 2.5” SATA SSD 256GB

1.4 SATA Interface

EverGreen Plus 2.5" SATA SSD support SATA II interface, and backward compliant with SATA I Spec.

1.5 Capacities

EverGreen Plus 2.5" SATA SSD is available in five capacities: 6GB, 12GB, 25GB, 50GB, 100GB and 200GB. The drives ship with 8GB, 16GB, 32GB, 64GB, 128GB and 256GB of MLC NAND on them by default. Roughly 20% of the drive capacity is designated as spare area for L^2 Architecture and bad block replacement.

1.6 2.5-inch form factor

EverGreen Plus 2.5" SATA SSD has a compact design 99.88mm (L) x 69.63mm (W) x 9.3mm (H) with metal material case, and is easy for installation.

2 Theory of operation

2.1 Overview

Figure 2 shows the operation of EverGreen Plus 2.5” SATA SSD from the system level, including the major hardware blocks.

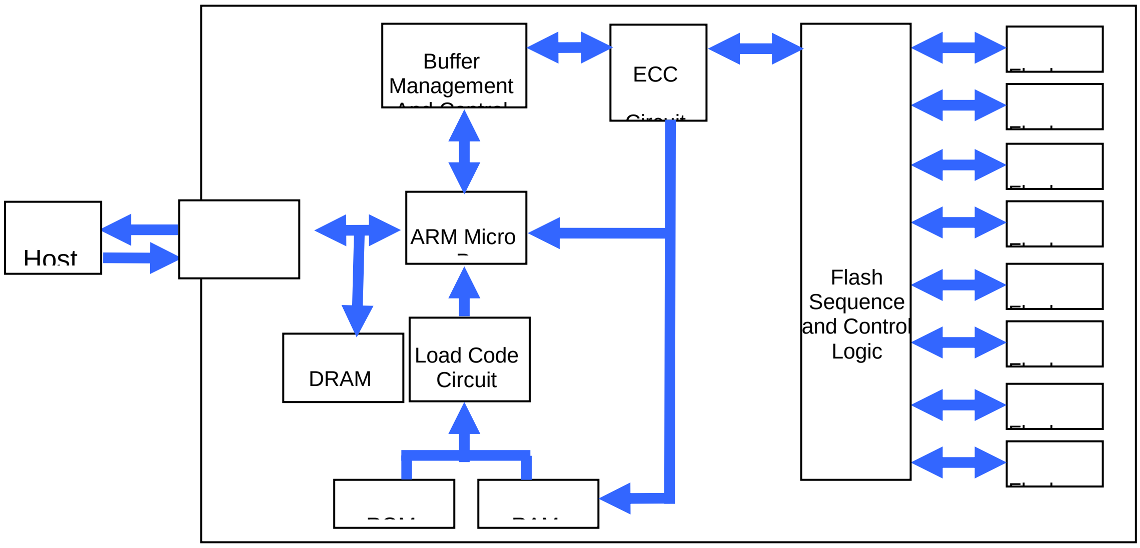


Figure 2: EverGreen Plus 2.5” SATA SSD Block Diagram

EverGreen Plus 2.5” SATA SSD integrates a SATA II controller, external DRAM, and NAND flash memories. Communication with the host occurs through the host interface, using the standard ATA protocol. Communication with the flash device(s) occurs through the flash interface.

2.2 SATA II Controller

The SATA II controller is 3.0 Gbps (Gen. 2), and support hot-plug. The Serial ATA physical, link and transport layers are compliant with Serial ATA Gen 1 and Gen 2 specification (Gen 2 supports 1.5Gbps/3.0Gbps data rate). The controller has 8 channels for flash interface.

The controller is equipped with 128KB of internal memory. The internal memory is used as an intermediate memory for storing data blocks during a wear-leveling procedure. A 32KB internal boot ROM includes basic routines for accessing the flash memories and for loading the main code into the internal memory.

2.3 Error Detection and Correction

Highly sophisticated Error Correction Code algorithms are implemented. The ECC unit consists of the Parity Unit (parity-byte generation) and the Syndrome Unit (syndrome-byte computation). This unit implements an algorithm that can correct 16 bits per 512 bytes in an ECC block. Code-byte generation during write operations, as well as error detection during read operation, is implemented on the fly without any speed penalties.

2.4 Wear-Leveling

Flash memory can be erased within a limited number of times. This number is called the ***erase cycle limit*** or ***write endurance limit*** and is defined by the flash array vendor. The erase cycle limit applies to each individual erase block in the flash device.

EverGreen Plus 2.5" SATA SSD uses a static wear-leveling algorithm to ensure that consecutive writes of a specific sector are not written physically to the same page/block in the flash. This spreads flash media usage evenly across all pages, thereby extending flash lifetime.

2.5 Bad Blocks Management

Bad Blocks are blocks that contain one or more invalid bits whose reliability are not guaranteed. The Bad Blocks may be presented while the SSD is shipped, or may develop during the life time of the SSD. When the Bad Blocks is detected, it will be flagged, and not be used anymore. The SSD implement Bad Blocks management, Bad Blocks replacement, Error Correct Code to avoid data error occurred. The functions will be enabled automatically to transfer data from Bad Blocks to spare blocks, and correct error bit.

2.6 Power cycling protection and circuit design

EverGreen Plus is designed with a unique circuit to prevent abnormal power failure. With its real time power management function, and advanced L^2 Architecture, EverGreen Plus can effectively prevent power cycling issue, as well as keep data completely be written into disk.

Moreover, with built in iCell* function, EverGreen Plus can not only keep power stable, but also ensure all data can be written into disk, once suddenly power shot down,

*iCell is optional function of EverGreen Plus.

3 Installation Requirements

3.1 EverGreen Plus 2.5" SATA SSD Pin Directions

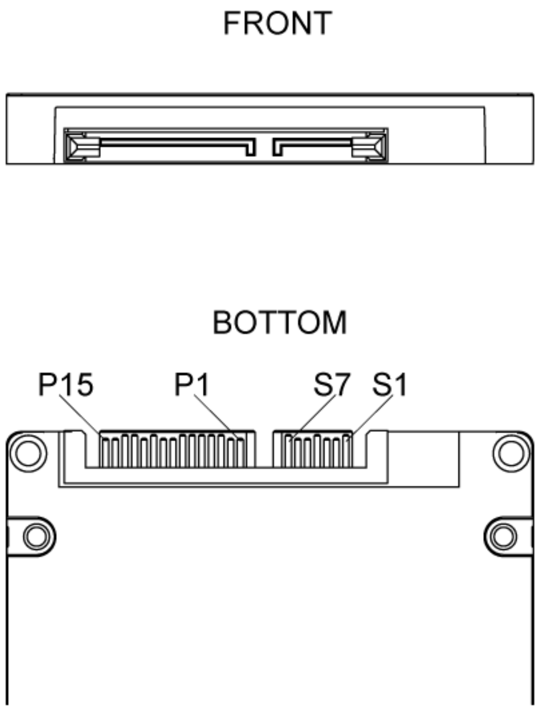


Figure 3: Signal Segment and Power Segment

3.2 Electrical Connections for EverGreen Plus 2.5" SATA SSD

A Serial ATA device may be either directly connected to a host or connected to a host through a cable. For connection via cable, the cable should be no longer than 1meter. The SATA interface has a separate connector for the power supply. Please refer to the pin description for further details.

3.3 Form Factor

Please prepare following things:

- Screw driver.
- Four M3 screws.
- SATA single cable (7-pin, Maximum length l meter).
- SATA power cable (15-pin).

Please turn off your computer, and open your computer's case. Find one of available 2.5-inch slot, and plug the SSD in. To use the screws fix the SSD. Plug in the SATA single cable, and power cable.

Please boot the installation Operation System from CD-ROM, and install Operation System into SSD.

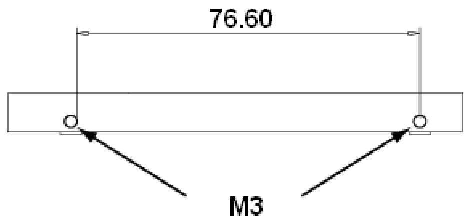


Figure 4: EverGreen Plus 2.5" SATA SSD Mechanical Screw Hole

3.4 Device drive

No additional device drives are required. The EverGreen Plus 2.5" SATA SSD can be configured as a boot device.

4 Specifications

4.1 CE and FCC Compatibility

EverGreen Plus 2.5” SATA SSD conforms to CE and FCC requirements.

4.2 RoHS Compliance

EverGreen Plus 2.5” SATA SSD is fully compliant with RoHS directive.

4.3 Environmental Specifications

4.3.1 Temperature Ranges

Operating Temperature Range:

- Standard Grade: 0°C to +70°C
- Industrial Grade: -40°C to +85°C

Storage Temperature Range:

- Standard Grade: -55°C to +95°C

4.3.2 Humidity

Relative Humidity: 10-95%, non-condensing

4.3.3 Shock and Vibration

Table 1: Shock/Vibration Testing for EverGreen Plus 2.5” SATA SSD

Reliability	Test Conditions	Reference Standards
Vibration	7 Hz to 2K Hz, 20G, 3 axes	IEC 68-2-6
Mechanical Shock	Duration: 0.5ms, 1500 G, 3 axes	IEC 68-2-27

4.3.4 Mean Time between Failures (MTBF)

Table 2 summarizes the MTBF prediction results for various EverGreen Plus 2.5” SATA SSD configurations. The analysis was performed using a RAM Commander™ failure rate prediction.

- **Failure Rate**: The total number of failures within an item population, divided by the total number of life units expended by that population, during a particular measurement interval under stated condition.
- **Mean Time between Failures (MTBF)**: A basic measure of reliability for repairable items: The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.

•

Table 2: EverGreen Plus 2.5" SATA SSD MTBF

Product	Condition	MTBF (Hours)
EverGreen Plus 2.5" SATA SSD	Telcordia SR-332 GB, 25°C	>4,000,000

4.4 Endurance

Read Cycles: Unlimited Read Cycles.

Data Retention: 10 years.

Wear-Leveling Algorithm: Support.

Bad Blocks Management: Support

Error Correct Code: Support

4.5 Transfer Mode

EverGreen Plus 2.5" SATA SSD support following transfer mode:

Ultra DMA 0~6

Serial ATA I 1.5Gbps

Serial ATA II 3.0Gbps

4.6 Pin Assignment

EverGreen Plus 2.5" SATA SSD uses a standard SATA pin-out. See Table 3 for EverGreen Plus 2.5" SATA SSD pin assignments.

Table 3: EverGreen Plus 2.5" SATA SSD Pin Assignment

Name	Type	Description
S1	GND	NA
S2	A+	Differential Signal Pair A
S3	A-	
S4	GND	NA
S5	B-	Differential Signal Pair B
S6	B+	
S7	GND	NA
Key and Spacing separate signal and power segments		
P1	NC	NC
P2	NC	NC
P3	NC	NC
P4	GND	NA

P5	GND	NA
P6	GND	NA
P7	V5	5V Power, Pre-Charge
P8	V5	5V Power
P9	V5	5V Power
P10	GND	NA
P11	DAS/DSS	Device Activity Signal / Disable Staggered Spinup
P12	GND	NA
P13	NC	NC
P14	NC	NC
P15	NC	NC

4.7 Mechanical Dimensions

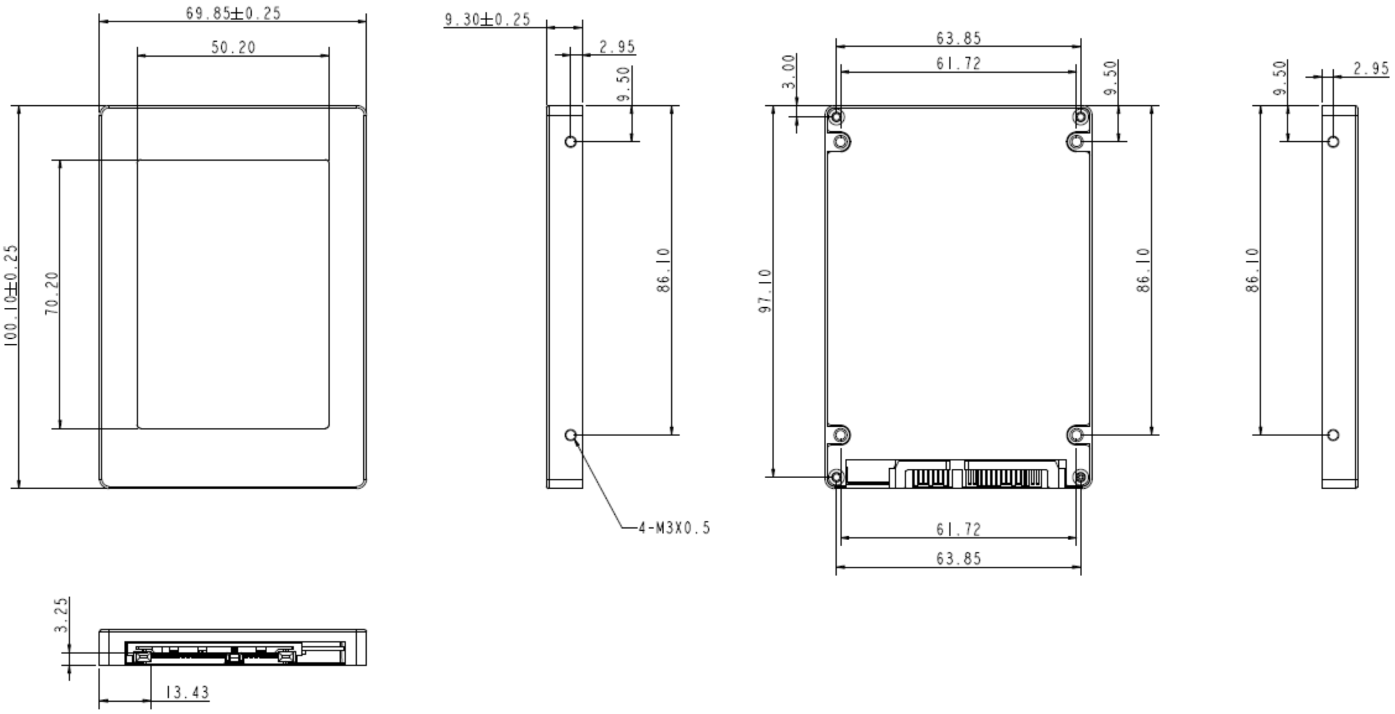


Figure 4: EverGreen Plus 2.5" SATA SSD mechanical dimensions

4.8 Assembly weight

An EverGreen Plus 2.5" SATA SSD within flash ICs, 32GB's weight is 90 grams approx. If the capacity is different, the flash chip's weight needs to be added. However, the total weight of SSD will be less than 95 grams.

4.9 Performance

Burst Transfer Rate: 3.0 Gbps

128GB, 256GB

Sustained Read : 220MB/sec (max.)

Sustained Write : 150MB/sec (max.)

64GB:

Sustained Read : 220MB/sec (max.)

Sustained Write : 70MB/sec (max.)

32GB:

Sustained Read : 220MB/sec (max.)

Sustained Write : 50MB/sec (max.)

16GB:

Sustained Read : 110MB/sec (max.)

Sustained Write : 25MB/sec (max.)

8GB:

Sustained Read : 60 MB/sec (max.)

Sustained Write : 15 MB/sec (max.)

4.10 IOPS

Random 4 KB Write: 2,200 IOPS (max.); 750 IOPS (min.)

4.11 Seek Time

EverGreen Plus 2.5” SATA SSD is not a magnetic rotating design. There is no seek or rotational latency required.

4.12 Hot Plug

The SSD support hot plug function and can be removed or plugged-in during operation. User has to avoid hot plugging the SSD which is configured as boot device and installed operation system.

Surprise hot plug : The insertion of a SATA device into a backplane (combine signal and power) that has power present. The device powers up and initiates an OOB sequence.

Surprise hot removal: The removal of a SATA device from a powered backplane, without first being placed in a quiescent state.

4.13 NAND Flash Memory

EverGreen Plus 2.5” SATA SSD uses Multi Level Cell (MLC) NAND flash memory, with InnoDisk L^2 Wear Leveling Architecture Firmware.

4.14 Electrical Specifications

4.14.1 Power Requirement

Table 4: EverGreen Plus 2.5” SATA SSD Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	+5DC +- 5% 500mA (max.)	V

4.14.2 Power Consumption

Table 5: Power Consumption

Mode	Power Consumption (mA) *base on 32GB
Read	376
Write	352
Idle	214

4.15 Device Parameters

EverGreen Plus 2.5” SATA SSD is designed with InnoDisk L^2 Wear Leveling Architecture, and is available in five capacities: 6GB, 12GB, 25GB, 50GB, 100GB and 200GB. The drives ship with 8GB, 16GB, 32GB, 64GB, 128GB and 256GB of MLC NAND on them by default. Roughly 20% of the drive capacity is designated as spare area for wear leveling and bad block replacement.

EverGreen Plus 2.5” SATA SSD device parameters are shown in Table 6.

Table 6: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User capacity (MB)
8GB	13242368	13137	16	63	6466
16GB	26484736	16383	16	63	12932
32GB	52969472	16383	16	63	25864
64GB	105938944	16383	16	63	51728
128GB	211877888	16383	16	63	103456

256GB	423755776	16383	16	63	206912

5 Supported ATA Commands

5.1 Supported ATA Commands

EverGreen Plus 2.5" SATA SSD supports the commands listed in Table 7.

Table 7: ATA Commands

Command Name	Code	PARAMETERS USED					
		SC	SN	CY	DR	HD	FT
CHECK POWER MODE	E5h	X	X	X	O	X	X
EXECUTE DIAGNOSTICS	90h	X	X	X	O	X	X
FLUSH CACHE	E7h	X	X	X	O	O	X
IDENTIFY DEVICE	ECh	X	X	X	O	X	X
IDLE	E3h	O	X	X	O	X	X
IDLE IMMEDIATE	E1h	X	X	X	O	X	X
INITIALIZE DEVICE PARAMETERS	91h	O	X	X	O	O	X
READ DMA	C8h or C9h	O	O	O	O	O	X
READ MULTIPLE	C4h	O	O	O	O	O	X
READ SECTOR(S)	20h or 21h	O	O	O	O	O	X
READ VERIFY SECTOR(S)	40h or 41h	O	O	O	O	O	X
RECALIBRATE	10h	X	X	X	O	X	X
SECURITY DISABLE PASSWORD	F6h	X	X	X	O	X	X
SECURITY ERASE PREPARE	F3h	X	X	X	O	X	X
SECURITY ERASE UNIT	F4h	X	X	X	O	X	X
SECURITY FREEZE LOCK	F5h	X	X	X	O	X	X
SECURITY SET PASSWORD	F1h	X	X	X	O	X	X
SECURITY UNLOCK	F2h	X	X	X	O	X	X
SEEK	7xh	X	X	O	O	O	X
SET FEATURES	EFh	O	X	X	O	X	O
SET MULTIPLE MODE	C6h	O	X	X	O	X	X
SLEEP	E6h	X	X	X	O	X	X
SMART	B0h	X	X	O	O	X	O
STANDBY	E2h	X	X	X	O	X	X
STANDBY IMMEDIATE	E0h	X	X	X	O	X	X
WRITE DMA	CAh or CBh	O	O	O	O	O	X
WRITE MULTIPLE	C5h	O	O	O	O	O	X
WRITE SECTOR(S)	30h or 31h	O	O	O	O	O	X

Note:

O = Valid,

X = Don't care

SC = Sector Count Register

SN = Sector Number Register

CY = Cylinder Low/High Register

DR = DEVICE SELECT Bit (DEVICE/HEAD Register Bit 4)

HD = HEAD SELECT Bit (DEVICE/HEAD Register Bit 3-0)

FT = Features Register

6 Part number rule

CODE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	D	2	S	L	-	A	2	8	J	2	0	A	C	2	E	N				
Description	Disk	2.5" EverGreen Plus SSD			-	Capacity			Category			FW	Operation Temp.	Internal Control	Ch.	Flash	-	Customized Code		

Definition

Code 1st (Disk)	Code 12th (Firmware Version)
D: Flash Disk	A: Standard F/W version
Code 2nd ~ 4th (Product Model)	**Code 13th (Operation Temperature)**
2SL: 2.5" EverGreen Plus SSD	C: Standard Grade (0℃ ~ +70 ℃)
	W: industrial Grade (-40℃ ~ +85 ℃)
Code 6th ~8th (Capacity)	**Code 14th (Internal Control Code)**
08G: 8GB	2: 2nd PCB version, default setting
16G: 16GB	
32G: 32GB	**Code 15th (Channel of Data Transfer)**
64G: 64GB	D: Dual Channels
A28: 128GB	Q: Four Channels
B56: 256GB	E: Eight Channels
Code 9th ~ 11th (Series)	**Code 16th (Flash Type)**
J20: EverGreen Plus series	N: Micron MLC